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Description

[CIRCUIT CONNECTING STRUCTURE AND FABRICATING METHOD THEREOF]

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the priority benefit of Taiwan application serial no. 93110638, filed April 16, 2004.

BACKGROUND OF INVENTION

[0002] Field of Invention

[0003] The present invention relates to a connecting structure, and more particularly, to a circuit connecting structure, where a depth/width ratio of a via hole is reduced under a fixed via hole width.

[0004] Description of the Related Art

[0005] As fabrication technology of electronics industry develops and proceeds rapidly, a printed circuit board (PCB) displaces conventional wiring welding assembly system. Since a PCB is capable of disposing with miniature electronics parts, it is widely adopted by the industry. As an

integrated circuit (IC) and a computer system are successfully invented, circuit design becomes increasingly intricate and complicated. Therefore, single layered PCB is not capable of serving for routing layout, whereas double-layered PCB and multi-layered PCB are disclosed as a consequence. In IC packaging field, a PCB not only serves as the motherboard of a computer system, but also serves as a substrate for IC packaging. In order to increase trace density within limited substrate dimension, increasing trace density is realized by coupling at least two patterned circuit layers with at least one circuit connecting structure.

[0006] Referring to *FIG. 1A*, a schematic cross-sectional diagram of a circuit connecting structure is illustrated. In *FIG. 1A*, the circuit connecting structure *101* is a double-layered board, for example, hence a number of conductive layers is two. The conventional circuit connecting structure is applied to a circuit carrier (not illustrated), where the circuit carrier includes at least two patterned circuit layers (not illustrated). The circuit connecting structure *101* includes an insulating layer *110*, two conductive layers *120* and *122*, a via hole *130* and a conductive film *124*, wherein the insulating layer *110* is generally composed of epoxy resin, and the conductive layers *120* and *122* are generally

composed of copper. The conductive layers *120* and *122* are respectively disposed over two surfaces *112* and *114* of the insulating layer *110*, and the via hole *130* of the circuit connecting structure *101* is formed by etching or direct laser drilling for penetrating through the conductive layer *120* and the insulating layer *110*.

[0007] Referring to *FIG. 1B*, a schematic cross-sectional diagram of the circuit connecting structure of *FIG. 1A* is illustrated, where the conductive film is non-uniformly distributed over sidewalls of the via hole. In *FIG. 1B*, a conductive film *124*, disposed over the circuit connecting structure *101* such that the via hole manages to electrically coupling the conductive layers *120* and *122*, is formed by electroplating or plug electroplating. When the conductive film *124* forming the via hole *130*, electronic charges aggregate around a tip area where the conductive layer *120* and the via hole *130* are joined, thus the conductive film *124* is thicker around the area thereof. In contrast, the conductive film *124* is thinner around the bottom of the via hole *130*. Since the via hole *130* is generally formed with laser drilling process, the width thereof is usually consistent, yet the depth is usually too deep (about over 100μm), thus a width/depth ratio is too high to form a uniform

conductive film *124* in the via hole *130*.

[0008] Referring to *FIG. 1C*, a schematic cross-sectional diagram of the circuit connecting structure is illustrated, where a void is formed with the conductive film. In *FIG. 1C*, when the thickness of the conductive film *124* is increased, the conductive film *124* around the top of the via hole *130* may be connected and closed. A void *140* is thus formed around the bottom of the via hole *130* where air is accommodated and a bubble is formed. Therefore reliability of fabricating conductive film *124* of the circuit connecting structure is reduced.

SUMMARY OF INVENTION

[0009] According to one aspect of the present invention, a circuit connecting structure is provided, where a via hole is fabricated shallower as width thereof is fixed, so that a depth/width ratio of the via hole is relatively smaller, for avoiding a void or a bubble when a film is electroplated.

[0010] According to another aspect of the present invention, a fabricating method of a circuit connecting structure is provided, where a via hole is fabricated shallower as width thereof is fixed, so that a depth/width ratio of the via hole is relatively smaller, for avoiding a void or a bubble when a film is electroplated.

[0011] According to the present invention, a circuit connecting structure applied to a circuit carrier is provided, wherein the circuit carrier includes at least a first patterned circuit layer and a second patterned circuit layer. The connecting circuit structure includes a first insulating layer, a second insulating layer, a conductive pad, a first conductive layer and a second conductive layer, wherein the first insulating layer is penetrated with a first via hole. The second insulating layer is penetrated with a second via hole, and the second insulating layer is formed over the first insulating layer. The conductive pad is disposed between the first insulating layer and the second insulating layer, where the two surfaces of the conductive pad are respectively connected to the first via hole and the second via hole. The first conductive layer is disposed over the surface of the first insulating layer that is away from the second insulating layer, and is disposed in the first via hole for connecting to the conducting pad, for forming a first patterned circuit layer. The second conductive layer is disposed over the surface of the second insulating layer away from the first insulating layer, and is disposed in the second via hole for connecting to the conductive pad, for forming a second patterned circuit layer.

[0012] According to one aspect of the circuit connecting structure in the present invention, wherein the conductive pad, the first conductive layer, and the second conductive layer are composed of copper.

[0013] According to one aspect of the circuit connecting structure of the present invention, wherein the first insulating layer and the second insulating layer are comprised of epoxy resin.

[0014] According to another aspect of the present invention, a fabricating method of the circuit connecting structure applied to a circuit carrier is provided, wherein the circuit carrier includes a first patterned circuit layer and a second patterned circuit layer. The fabricating method of the circuit connecting structure includes the following steps. First, forming a first conductive pad over a surface of a first insulating layer, and forming a first conductive layer over the other surface of the first insulating layer. Second, forming a second insulating layer over the surface of the first insulating layer and covering the conductive pad, and forming a second conductive layer over the off surface of the second insulating layer. Then, forming a first via hole from the first conductive layer through the first insulating layer for exposing the conductive pad, and forming a sec-

ond via hole from the second conductive layer through the second insulating layer for exposing the conductive pad. Lastly, forming a third conductive layer in the first via hole for coupling the conductive pad to the first conductive layer, and defining the third conductive layer and the first conductive layer to form a first patterned circuit layer; and forming a fourth conductive layer in the second via hole for coupling the conductive layer to the second conductive layer, and defining the fourth conductive layer and the second conductive layer to form a second patterned circuit layer.

[0015] According to the above description, the connecting circuit structure is formed between two insulating layers with a conductive pad, and the two conductive layers are respectively disposed over an insulating layer and a via hole on a same side of the circuit connecting structure, such that two conductive layers are electronically coupled to each other via the conductive pad. Therefore, with a fixed width of the via holes, a depth of each via holes can be reduced as well as the width/depth ratio, such that the conductive layer in the via hole is more uniformly formed, and a void or a bubble thereof is effectively avoided according to the circuit connecting structure in the present invention.

BRIEF DESCRIPTION OF DRAWINGS

[0016] *FIG. 1A* is a schematic diagram illustrating cross-sectional view of a circuit connecting structure according to conventional art.

[0017] *FIG. 1B* is a schematic diagram illustrating cross-sectional view of a circuit connecting structure according to conventional art where conductive layer is non-uniformly formed on the sidewalls of the via hole.

[0018] *FIG. 1C* is a schematic diagram illustrating cross-sectional view of a circuit connecting structure according to conventional art where part of the conductive layer is connected and a void is formed thereby.

[0019] *FIG. 2* is a schematic diagram illustrating cross-sectional view of a circuit connecting structure according to an embodiment of the present invention.

[0020] *FIG. 3A* is a schematic cross-sectional view of a circuit connecting structure including an insulating layer, a conductive layer, and a conductive pad according to an embodiment of the present invention.

[0021] *FIG. 3B* is a schematic diagram illustrating cross-sectional view of a circuit connecting structure including an additional insulating layer and a conductive layer according to an embodiment of the present invention.

[0022] *FIG. 3C* is a schematic diagram illustrating cross-sectional view of a circuit connecting structure including two additional via holes according to an embodiment of the present invention.

[0023] *FIG. 3D* is a schematic diagram illustrating cross-sectional view of a circuit connecting structure including two additional conductive layers in the two via holes respectively according to an embodiment of the present invention.

[0024] *FIG. 4* is a schematic flow chart diagram illustrating steps of fabrication method of a circuit connecting structure according to an embodiment of the present invention.

DETAILED DESCRIPTION

[0025] Referring to *FIG. 2*, it illustrates a schematic diagram of cross-sectional view of a circuit connecting structure according to an embodiment of the present invention. The circuit connecting structure *200* according to the present invention is embodied with a double-layered substrate, for example, and is applied to a circuit carrier (not illustrated), wherein the circuit carrier includes at least two patterned circuit layers (not illustrated). The circuit connecting structure *200* includes two insulating layers *210* and *212*, a conductive pad *220*, two conductive layers *230* and *232*, wherein a via hole *240* is formed from the insu-

lating layer *210* through the insulating layer *210*, and a via hole *242* is formed from the insulating layer *212* through the insulating layer *212*, where the insulating layer *212* is formed over the insulating layer *210*. The conductive pad *220* is disposed between the two insulating layers *210* and *212*, and the two surfaces *220a* and *220b* of the conductive pad *220* are connected to the via holes *240* and *242* respectively. The conductive layer *230* is disposed on the surface *210b* of the insulating layer *210* and in the via hole *240* for connecting to the conductive pad *220*. The conductive layer *232* is disposed on the surface *212a* of the insulating layer *212* and in the via hole *242* for connecting to the conductive pad *220*, and the conductive layer *230* and *232* serve to form a patterned circuit layer respectively. The material of the insulating layer *210* and *212* includes epoxy resin, and the material to the conductive pad *220* and conductive layers *230* and *232* includes copper, for example, such that the two conductive layers *230* and *232* are electrically connected to each other via the conductive pad *220*.

[0026] Referring to *FIG. 4*, it illustrates a schematic flow chart of a fabricating method of the circuit connecting structure according to one embodiment of the present invention. In

FIG. 3A, a schematic diagram of cross-sectional view of a circuit connecting structure according to one embodiment of the present invention is depicted, including an insulating layer, a conductive layer, and a conductive pad. Referring to *FIG. 4* and *3A* together, a fabricating method of the circuit connecting structure includes the following steps. First, forming a conductive pad *220* over a surface *210a* of an insulating layer *210*, i.e. the first insulating layer cited in step *310*. The defining method of the conductive pad *220* includes etching, for example, and forming a conductive layer *230*, i.e. the first conductive layer cited in step *310*, over a surface *210b* of the insulating layer *210*.

[0027] In *FIG. 3B*, it illustrates a circuit connecting structure depicted in *FIG. 3A* with additional one insulating layer and a conductive layer. Referring to *FIG. 4* and *3B* together, forming an insulating layer *212*, i.e. the second insulating layer in step *320*, over a surface *210*a of the insulating layer *210* covering the conductive pad *220*, and forming a conductive layer *232*, i.e. the second conductive layer cited in step *320*, over a surface *212*a of the insulating layer *212*. The fabricating procedure of the additional insulating layer *212* and conductive layer *232* includes compressing a resin coated copper or compressing a resin then plating a

copper film, for example.

[0028] Referring to *FIG. 3C*, it is a schematic diagram illustrating cross-sectional view of a circuit connecting structure depicted in *FIG. 3B*, where two via holes are further formed. Referring to *FIG. 4* and *3C* together, forming a via hole *240*, i.e. the first via hole cited in step *330*, from the conductive layer *230* through the insulating layer *210* for exposing the conductive pad *220*, and forming a via hole *242*, i.e. the second via hole cited in step *330*, from the conductive layer *232* through the insulating layer *212* for exposing the conductive pad *220*. The via holes *240* and *242* are formed with procedures such as laser drilling, mechanics drilling, plasma etching, or photolithography method.

[0029] Referring to *FIG. 3D*, it is a schematic diagram illustrating cross-sectional view of a circuit connecting structure depicted in *FIG. 3C*, where two conductive layers are added in the two via holes. Referring to *FIG. 4* and *3D* together, forming a conductive layer *234*, i.e. the third conductive layer cited in step *340*, in the via hole*240* for connecting the conducting pad *22* with the conductive layer *230*, and defining the conductive layer *234* and *230* for forming a patterned circuit layer. Moreover, forming a conductive layer *236*, i.e. the fourth conductive layer cited in step *340*,

in the via hole *242* for connecting the conductive pad *220* and the conductive layer *232*, and defining the two conductive layers *230* and *232* to form a patterned circuit layer, such that the two conductive layers *230* and *232* are electrically coupled to each other via the conductive pad *220*. The additional conductive layers *234* and *236* in the via holes *240* and *242* are fabricated with electrical electroplating or plug electroplating method, or with a filling method with metal paste, a conductive polymer, etc., whereas the defining method includes photolithography method, for example.

[0030] According to the circuit connecting structure and fabricating method in the above descriptions, since a conductive pad is disposed between two insulating layers, the two conductive layers are electrically coupled to each other via the conductive pad. Therefore, a depth of the via hole according to an embodiment of the present invention is reduced to about temp60tempμm, for example, such that a depth/width ratio of via hole is substantially reduced with the width remains about the same. Furthermore, the conductive layer formed in the via hole is distributed more uniformly for avoiding voids or bubbles that may occur in the conductive layer in the via hole. Higher reliability for

forming additional layers in the via holes is provided according to the circuit connecting structure in the present invention.

[0031] Although the invention has been described with reference to a particular embodiment thereof, it will be apparent to those skilled in the art that modifications to the described embodiment may be made without departing from the spirit of the invention. Accordingly, the scope of the invention will be defined by the attached claims and not by the above detailed description.